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Research Article

Conservation perceptions and attitudes regarding monitor lizards in West Bengal, India

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Abstract

Local and illegal exploitation of wildlife is particularly widespread in highly populated and bio-diverse countries such as India. In such countries, illicit utilization practices and how these are perceived among local communities are commonly not well-documented. Due to a lack of data, and environmental education measures to protect ecosystems and biodiversity, the extent of this exploitation appears immense and often goes unnoticed. Therefore, in 2019, a series of awareness workshops targeting the conservation of wildlife focused on monitor lizards (Varanidae) was conducted in five districts of West Bengal, India. The environmental awareness workshops were conducted through PowerPoint slide presentations and questionnaires collecting baseline data from the participants regarding their perceptions and relationships to the three species of *Varanus* recorded for West Bengal. Our findings reveal specific human attitudes and varying local utilization patterns of monitor lizards. This study was the first to communicate and spread awareness in the study areas about why the conservation of local wildlife such as *Varanus* species is important for ecosystems and human well-being based on the 'Nature Contributions to People Concept'.

Key words: Awareness, ecosystem services, educational workshops, nature protection, *Varanidae*, wildlife exploitation

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Introduction

Direct drivers of biodiversity loss, destruction, and destabilization of ecosystems are the alteration of habitats, exploitation of biodiversity, climate change, pollution, and invasive species. These factors are underpinned by societal values and behaviors, such as e.g., production and consumption patterns (IPBES 2019). Accordingly, the over-exploitation of wildlife is considered the second largest threat to terrestrial wildlife (Díaz et al. 2019). Thus, human population

growth and the spread of human populations into rural areas can shift the domestic use of biodiversity from formerly sustainable to unsustainable exploitation (Dasgupta 2021).

Human-wildlife relationships have always played a crucial role in the conservation and exploitation of species and their habitats (Castillo-Huitrón et al. 2020). Traditional beliefs, ethical values, and culturally shared emotions are considered essential in shaping the attitudes of societies and communities towards their environment (Jacobs 2012; Castillo-Huitrón et al. 2020).

In India, the uses of monitor lizards (family Varanidae) and their body parts have been documented since prehistoric times as is evident from cave paintings, as well in the use of Unani medicines which dates back 2500 years before the present (Das 1989; Yuan et al. 2016). Hence, since ancient times to the present day, there is evidence of the local exploitation of monitor lizards in the Indian subcontinent (Auffenberg 1989; Das 1989; Bhattacharya and Koch 2018a, 2018b; Choudhury and Choudhury 2019; Sharma et al. 2019). Since 1972, however, that utilization is considered illegal according to the Wildlife (Protection) Act of India (The Parliament of India, 1972). Four species of monitor lizards are native to India, i.e., the Bengal monitor (*Varanus bengalensis*), the common water monitor (*V. salvator*), the yellow monitor (*V. flavescens*), and the desert monitor (*V. griseus*), of which all but the latter species occur in West Bengal (Koch et al. 2013; Chatterjee and Bhattacharyya 2015; Auliya and Koch 2020). All four species are nationally protected in Schedule I, Part II under the Wildlife (Protection) Act of India, 1972. Despite their national protection status, ongoing exploitation and illegal trade across several districts of the country are evident (Das 1989; Chakravorty et al. 2011; Bhupathy et al. 2013; Bhattacharya and Koch 2018a, 2018b; Choudhury and Choudhury 2019; Sharma et al. 2019). Besides, the active involvement and participation of local communities represent a major component of conservation efforts regarding *Varanus* species and their habitats (Sodhi et al. 2010; Bhattacharya and Koch 2018a). Hence, environmental educational workshops are important to inform local communities that a detrimental impact on wildlife not only reduces the resilience of ecosystems but disables ecosystems' services and harms human health (Oražem et al. 2019; WHO 2021; Lin et al. 2022; Ulrich et al. 2023). Several such awareness programs have previously been conducted in different parts of India such as a study on the conservation attitudes and awareness in the Kaziranga National Park, Assam (Heinen and Shrivastava 2009); an education awareness program for the conservation of the endangered medicinal shrub *Commiphora wightii* in Rajasthan (Soni 2010); community awareness programs for the conservation of endangered turtle species in north-east India (Baruah et al. 2011); surveys for identification of snake species in Kerala prioritizing the importance of awareness programs for snake conservation (Roshnath and Divakar 2019), or in gharial (*Gavialis gangeticus*) conservation (Pathak et al. 2023). Furthermore, other studies conducted in different parts of the world communicated the importance of educational awareness programs leading to positive change in attitudes toward the conservation of species, especially among the younger generation (Mutalib et al. 2013; Feilen et al. 2018; Freund et al. 2019; Kamil et al. 2020; Sánchez-Mercado et al. 2020).

The major goal of our study was to spread awareness regarding the illicit exploitation of monitor lizards in five districts of West Bengal (Fig. 1), as well as

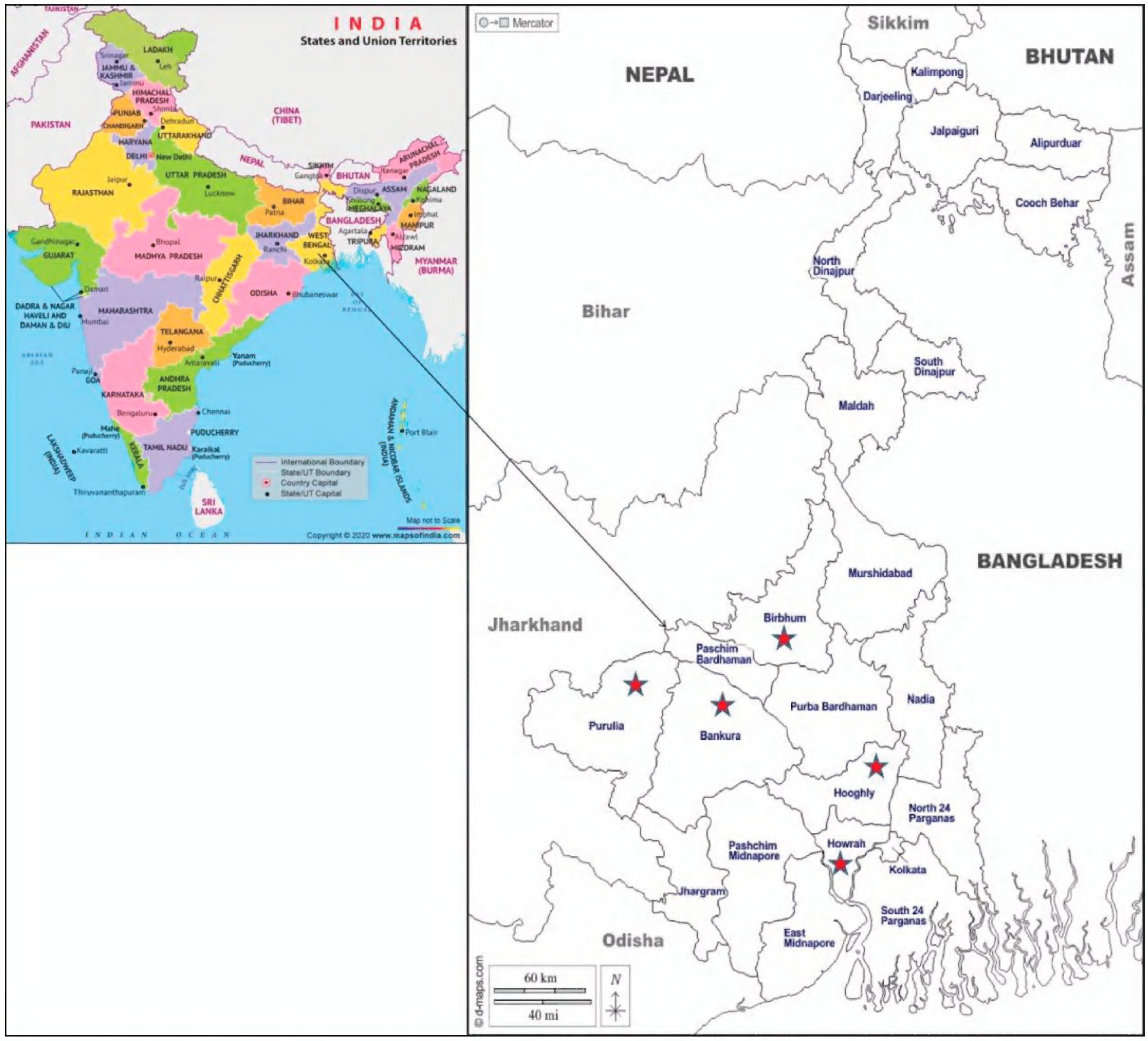

Figure 1. The five districts (denoted by stars) of West Bengal, India. The awareness workshops were conducted in these districts, namely Hooghly, Bankura, Purulia, Howrah, and Birbhum in 2019. Sources: https://www.maps.com; https://www.d-maps.com.

to obtain detailed baseline information about the perception trends of the local youth, which have not been investigated before in the study area. The aims and objectives of the workshops are also described in Bhattacharya et al. (2019). We believe that the perception trends from each district will give a perspective on the presence, utilization, and trade related to monitor lizards along with the attitudes of the local people towards this particular reptile group (Bhattacharya et al. 2019).

Materials and methods

Study site and sampling

To address perceptions and attitudes along with the traditional beliefs and values of local people towards Indian monitor lizards, awareness workshop programs entitled “Perceptions of Wildlife Conservation of Today’s Youth in West

Bengal, India, with a focus on Monitor Lizards" were jointly organized by the Environment, Agriculture and Education Society along with the IUCN Species Survival Commission's Monitor Lizard Specialist Group (IUCN SSC MLSG) in West Bengal, India. In the period from 29th July to 2nd August 2019, the workshops were conducted at four schools and five colleges (for details see Table 1) of five districts, i.e., Hooghly, Bankura, Purulia, Howrah, and Birbhum (Fig. 1) (Bhattacharya et al. 2019). The five districts were chosen for conducting the workshops based on our personal observations and ground surveys conducted before the workshops, since one of us (SB) lives in Kolkata (nearby to Howrah and Hooghly districts).

The target audience consisted of two age groups: (i) school students aged 12–18 years (467 participants) and (ii) college students between 18–24 years (595 participants) (Table 1).

Structure and content of workshops

The primary objectives of the workshops were to gain an understanding of the perceptions and attitudes of the younger generation towards the fragmentation and encroachment of forest and wetland ecosystems as well as the presence, interactions, conflicts, and local and illegal utilization of monitor lizards. The workshop presentation sessions consisted of (i) the introduction of wildlife diversity, its importance and conservation; (ii) the ecological role of monitor lizards and their value as part of a biocenosis, and why they need to be conserved; (iii) the importance of protecting the varying ecosystems, such as e.g., wetlands, marshlands, forest fringes, and tropical dry deciduous forests; (iv) to introduce and make the audience aware of the Wildlife (Protection) Act of India 1972 (including the protection status and the penalties related to the illegal exploitation of Indian monitor lizards); and (v) to make the youth aware of the exploitation of protected wildlife that is an important part of their living space.

Questionnaires

The workshops also included a survey of the participants, for which two questionnaires were developed (see Suppl. materials 1, 2). The first questionnaire was distributed to the participants before the presentation session

Table 1. Number of participants from schools and colleges of the five districts of West Bengal, India.

Districts	Institution names	Respondents	Total number of respondents
Birbhum	1. Suri Vidyasagar College	180	180
Bankura	1. Dhulai R.K.M. Vidyamandir H.S. School	89	
	2. Sonamukhi College	159	248
Purulia	1. Bamnia Vivekananda Vidyapith (H.S.)	180	
	2. Achhruram Memorial College	83	263
Howrah	1. Gangadharpur High School	80	
	2. Gangadharpur Sikshan Mandir	80	160
Hooghly	1. Itachuna Sree Narayan Institution (H.S.)	118	
	2. Bejoy Narayan Mahavidyalaya	93	211
	Total Respondents from Schools	**467**	
	Total Respondents from Colleges	**595**	**1062**

to obtain an unbiased judgement about various questions related to conservation parameters concerning wildlife in general as well as monitor lizards in particular. The second questionnaire focused on the feedback from the participants at the end of the workshop presentation session to investigate possible changes in the respondents' attitudes toward previously addressed environmental issues.

The first questionnaire comprised several questions, which were broadly categorised into ten topical areas for analysis, i.e., the perception of (i) the presence of biodiversity; (ii) the importance of wildlife conservation; (iii) the presence of wetlands; (iv) the destruction of wetlands; (v) the presence of monitor lizards; (vi) the attitude towards monitor lizards; (vii) the conflicts related to monitor lizards; (viii) the utilization of monitor lizards or their body parts other than genitalia; (ix) hunting of monitor lizards; and (x) the use of Hatha Jodi (i.e., the genitalia called hemipenes of monitor lizards) involved in illegal trade activities (Bhattacharya et al. 2019; D'Cruze et al. 2018). Questionnaires were arranged as multiple-choice questions for the convenience of the participants. Statistical graphs were used for the representation of the prominent results (see below). A comparative analysis of the categorized questions from the five districts was also conducted to gain an overview regarding the variation of the perception trend across the sampled regions. Also, as mentioned above, each categorized question consists of several sub-questions, and hence the prominent results of such individual questions are also discussed below.

For the comparative analysis of the questions from the five districts, only the multiple-choice options for the participants (such as "yes" and "no") were considered.

Results of feedback questionnaires were allocated into three main components regarding the perception of (i) a potential change in the attitude of the participants after the workshops, (ii) the protection of monitor lizards in India, and (iii) the intended future use of monitor lizards or their body parts by the participants. Thus, our analysis of the questionnaires should evaluate the overall success and efficiency of the conducted workshops.

Results

The data obtained from both the workshops and the feedback questionnaires provided a comprehensive overview of the perceptions and trends of the participants from the five districts in West Bengal. The respective number of participants from the schools and colleges are mentioned in Table 1. In total, 1062 students took part in the workshops.

Workshop questionnaire (Pre-presentation) data analysis

Statistics on the answers of all participants related to the questions of the nine topics are summarized in Table 2. The questions have been shortened for the sake of clarity. Also, summarized answers to a few open follow-up questions (i.e., Q4a, Q4b, Q15a, Q17a, Q19a, and Q20a) are included in Table 3. The option N.A. (i.e., not answered) refers to those participants, who did not respond to the options given in the questionnaires. Detailed answers for each district are provided in the Suppl. material 2: table S1.

Table 2. The overall perceptions of the participants from the five districts expressed in percentages of minimum and maximum values per district together with average (x) ± standard deviation (S.D.) from the Pre-Presentation Questionnaire.

Topics and sub-questions	Minimum - Maximum values (x = Average % ± Standard Deviation (S.D.)				
Presence of biodiversity	High	Moderate	Low	Not Sure	N.A.
(Q2): How would you describe the amount of wildlife and biodiversity in your area?	4.4–11.3% (x = 7.9 ± 2.5)	23.4–45% (x = 33.3 ± 8.7)	36.2–60% (x = 43.7 ± 9.3)	2.5–15.9% (x = 8.2 ± 5.6)	4.6–7.8% (x = 6.6 ± 1.31)
Perception of wildlife conservation	Yes	No	Not Sure	N.A.	
(Q3): Do you think that wildlife and biodiversity are essential for the subsistence of ecosystems?	71.8–93.9% (x = 83.9 ± 9.6)	1.8–9% (x = 4.6 ± 3.1)	0.5–11.9% (x = 5.1 ± 4.2)	3.3–9.79% (x = 6.2 ± 3.0)	
(Q4): Do you think that it is important to preserve local wildlife species?	77.5–90% (x = 84.4 ± 4.9)	4.3–13.1% (x = 8.0 ± 3.7)	2.5–6.8% (x = 5.2 ± 1.6)	0.9–3.9% (x = 2.2 ± 1.3)	
Perception of the presence of wetlands	Yes	No.	Not Sure	N.A.	
(Q5): Do you have natural wetlands in your area?	92.2–98.7% (x = 95.5 ± 3.0)	0.6–6.1% (x = 2.9 ± 2.2)	0–2.6% (x = 1.2 ± 0.8)	0–1.1% (x = 0.3 ± 0.4)	
(Q6): Are there artificial/ man-made wetlands in your area?	70.5–90.6% (x = 82.0 ± 7.7)	6.2–27.2% (x = 15.3 ± 7.6)	0.3–1.8% (x = 1.2 ± 0.6)	0–2.8% (x = 1.3 ± 1.0)	
Perception of the destruction of wetlands	Yes	No	Not Sure	N.A.	
(Q7): Is a wetland in your area being destroyed or turned into an agricultural land?	29.7–63.1% (x = 41.7 ± 14.0)	28.7–56.5% (x = 47.1 ± 11.3)	5.6–11.8% (x = 8.6 ± 2.3)	0–5.9% (x = 2.4 ± 2.1)	
(Q8): Do you think wetlands should be filled up for developmental activities such as agriculture and constructions?	9.1–30.0% (x = 17.7 ± 8.7)	55.9–75.6% (x = 68 ± 9.6)	4.8–12.3% (x = 9.8 ± 3.0)	1.8–9.2% (x = 4.3 ± 2.9)	
Perception of the presence of monitor lizards	Yes.	No	Not Sure	N.A.	
(Q9): Do you know monitor lizards ("Gosap" or "Gorgel")?	46–75.6% (x = 58.1 ± 11.5)	12.5–42.2% (x = 30.2 ± 11.3)	1.2–9.1% (x = 6.9 ± 3.2)	1.8–8.7% (x = 4.6 ± 2.5)	
(Q10): Do monitor lizards occur in your area?	38.8–84.3% (x = 58.1 ± 19.0)	10–47.7% (x = 29.5 ± 15.1)	3.1–13.7% (x = 9.7 ± 4.0)	1.3–3.7% (x = 2.4 ± 0.9)	
(Q11): Have you ever seen a monitor lizard?	52.5–96.8% (x = 73.4 ± 18.1)	2.5–39.5% (x = 22.2 ± 15.0)	0–5% (x = 1.8 ± 1.9	0.6–6.5% (x = 2.4 ± 2.4)	
Perception of the attitude towards monitor lizards	Positive	Negative	Neutral	N.A.	
(Q11a): If yes, how would you describe the interaction?	13.5–35% (x = 27.2 ± 9.6)	5–24.9% (x = 9.8 ± 8.6)	32.9–50% (x = 43.0 ± 7.4	10–31.6% (x = 19.8 ± 10.1)	
(Q12): How is your attitude towards monitor lizards in your area?	Positive	Negative	Neutral	N.A.	
	21.6–43.1% (x = 31.6 ± 8.6)	3.7–15.9% (x = 9.1 ± 4.5)	39.1–50.5% (x = 46.4 ± 4.3)	6.2–18.8% (x = 12.6 ± 5.3)	
Perception of conflicts with monitor lizards	Yes.	No	Not Sure	N.A.	
(Q13): Are you aware of conflicts with monitor lizards in your area?	14.7–47.5% (x = 32.0 ± 12.6)	23–43.1% (x = 33.1 ± 8.9)	13.8–31.8% (x = 22.3 ± 7.9)	7–16.6% (x = 12.3 ± 4.2)	

Topics and sub-questions	Minimum - Maximum values (x = Average % ± Standard Deviation (S.D.)						
(Q14): What kinds of conflicts exist?	Fish ponds	Garbage	Poultry		Others	N.A.	
	6.6–26.8% (x = 14.9 ± 7.5)	7.7–15% (x = 11.6 ± 3.3)	2.2–11.1% (x = 6.4 ± 3.3)		5–21% (x = 12.0 ± 5.7)	46.8–69.4% (x = 54.9 ± 9.72)	
Perception of utilization of monitor lizards	Yes	No	Not Sure		N.A.		
(Q15): Do you or anybody you know utilize monitor lizards?	5.5–14.5% (x = 9.7 ± 3.2)	63.5–75.6% (x = 72.6 ± 5.1)	9.7–13.8% (x = 11.4 ± 1.6)		3.2–12.1% (x = 6.1 ± 3.5)		
(Q16): Have you ever seen any items or products from monitor lizard being sold in local markets?	2.2–14.4% (x = 9.0 ± 4.3)	62.0–76.6% (x = 71.0 ± 5.5)	10.5–17.7% (x = 12.9 ± 2.9)		4.1–12% (x = 6.9 ± 3.28)		
(Q16a): If yes, please specify the type of item or product.	Leather	Meat	Oil	Medicines	Astrology	Others	N.A.
	1.1–10.9% (x = 6.3 ± 3.7)	0.5–3.6% (x = 2.5 ± 1.3)	0–8% (x = 2.6 ± 3.2)	03.2% (x = 2.1 ± 1.2)	0–2.6% (x = 1.2 ± 1.0)	1.97.8% (x = 3.7 ± 2.3)	73.894%, (x = 81.3 ± 8.4)
Perception of the hunting of monitor lizards	Yes	No	Not Sure		N.A.		
(Q17): Have you ever heard of people hunting monitor lizards or participating in the hunting?	23.8–36.8% (x = 27.4 ± 5.4)	50.0–63.8% (x = 58.9 ± 5.2)	5.4–11.6% (x = 8.1 ± 2.2)		3.5–9.5% (x = 5.4 ± 2.3)		
Perception of Hatha Jodi	Yes	No	Not Sure		N.A.		
(Q18): Do you know about Hatha Jodi/Kakanashika/ Bagnakhi?	0.9–5.7% (x = 3.0 ± 1.8)	80–88.9% (x = 83.3 ± 3.9)	5.4–11.2% (x = 7.9 ± 2.7)		3.6–8.6% (x = 5.6 ± 1.9)		
(Q19): Do you know anyone who sells Hatha Jodi?	0.5–3.6% (x = 2.1 ± 1.2)	70–85.2% (x = 78.8 ± 5.7)	5.9–13.1% (x = 9.4 ± 3.3)		4.8–15.6% (x = 9.6 ± 4.1)		
(Q20): Have you or anyone you know ever bought and used Hatha Jodi?	0.5–4.6% (x = 2.1 ± 1.7)	71.2–82.1% (x = 75.3 ± 4.6)	9.6–19.4% (x = 14.3 ± 3.6)		4.6–13.1% (x = 8.1 ± 3.7)		
(Q20b): If yes, what was the source?	Market	Online	Astrologers		Other	N.A.	
	0.3–5% (x = 2.4 ± 2.2)	0–4.7% (x = 1.4 ± 1.9)	0.5–4.5% (x = 2.4 ± 1.4)		1.8–9.9% (x = 5.1 ± 3.3)	81.3–96.6% (x = 88.4 ± 6.7)	

Table 3. Summary Results of the Qualitative Answers in the first Pre-Presentation questionnaire.

Questions	Summary of Qualitative Answers
Q4a	- Maintenance of the ecological balance of the environment
	- Every species has the same right as human beings to live
	- Important for the survival of human beings to survive in the future
Q4b	- Note, no participant preferred to answer this open question
Q15a	- Meat (belly fat is considered as a delicacy among the Santhal tribes)
	- Medicinal oil
	- Leather
	- Traditional musical instruments like drums used by the Santhal tribes
Q17a	- In their own villages and the neighbouring villages
	- Near the ponds and marshlands of the village or the neighbouring villages
	- In nearby forests and open areas
	- In agricultural areas
Q19a	- In Purulia district, used for medicinal purposes
Q20a	- Treatment of inflammation
	- For black magic/witchcraft

Regarding the origin of the respondents (Question 1), most of the participants (n = 887, i.e., 72%) were from rural areas, but this value varied from 44.38% (Howrah) to 91.17% (Bankura). Accordingly, Howrah district has the highest proportion (55.62%) of urban participants. This proportion was lowest in Bankura and Hooghly districts with 8.49% and 11.93%, respectively. Regarding the presence of biodiversity in their area (Question 2), more than one-third of the participants (x = 43.7% ± 9.3) from all districts opted for "low" (varying from 36.25% in Howrah to 60% in Birbhum), while one-third (x = 33.3% ± 8.7) chose the option "moderate", followed by a minority (x = 7.9% ± 2.5), which opted for "high" (Table 2).

Most respondents from Birbhum (91.11%), Howrah (89.69%), Hooghly (85.78%), Bankura (77.85%), and Purulia (76.52%) agreed that the conservation of local wildlife species and biodiversity is important for the subsistence of ecosystems (average values of Questions 3 and 4, for details see Suppl. material 2: table S1). There were two open follow-up questions provided along with Question 4. Those participants who opted "yes" to the importance of the conservation of wildlife species were asked "why do you think it is important?" (Question 4a). Here, the answers of most participants can be summarized as "the maintenance of the ecological balance of the environment", "every species has the same right as human beings to live" and a few stated "for the future survival of the human beings" (Table 3). Question 4b addressed those who opted for "no" for the same question (on average 8% across all districts), but none of these participants from any of the districts preferred to answer this open question.

The perception of the presence of natural and artificial wetlands, such as swamps, marshlands, and ponds, from all the districts is 95.5% and 82.0%, respectively (average values of Questions 5 and 6 in Table 2, for details see Suppl. material 2: table S1), which indicates that a considerable number of wetlands occur in the study area investigated. The perception of the destruction of these wetlands (Question 7) in the respective districts is highest in Howrah (63.13%) followed by Birbhum (48.33%), Hooghly (36.24%), Purulia (31.31%), and Bankura (29.71%). In this regard, the proportion of the participants favoring the idea of filling wetlands for developmental or agricultural purposes (Question 8) varied between 30% (Purulia) and 9.17% (Hooghly) with an average of 17.77%, while the majority (55.9%–75.6%, on average 68.06%) denied this question. Also, 9.8% of all the respondents preferred the option "Not sure" and 4.35% chose not to answer.

Question 9 tested whether participants were aware of monitor lizards (called "Gosap" or "Gorgel" in local dialects). 58.12% responded with "Yes" (varying between 46%–75.6%), while 30.28% stated they did not know monitor lizards. Participants who had no knowledge of the species from the five districts varied between 12.5% (Howrah) and 42.24% (Bankura) (see Suppl. material 2: table S1 for more details). Accordingly, 84.37% of participants from the Howrah district were aware of monitor lizards in their area (Question 10), while only 38.89% chose "yes" in Birbhum (overall average was 58.10%). Respondents who chose "no" ranged from merely 10% in Howrah to 47.78% in Birbhum (on average 29.59%). Between 3.13% (Howrah) and 13.75% (Purulia), on average 9.7%, were unsure if monitor lizards were found in their areas (Suppl. material 2: table S1).

Answers to Question 11 revealed that the overwhelming majority (96.88%) of the participants from the Howrah district had sighted a monitor lizard before, whereas only 52.5% of the students from Purulia stated "yes" (the average was

73.41%, Fig. 2). Accordingly, 39.51% of the participants from Purulia, 33.33% from Birbhum, 23.5% from Bankura, 12.39% from Hooghly and only 2.5% from Howrah claimed to have never seen a monitor lizard. Out of 73.41% of all participants who had sighted monitor lizards before, an average of 9.87% described their interaction as "negative", while "neutral" and "positive" interactions predominated on average 43.04% and 27.22%, respectively (Question 11a). Most of the negative interactions were reported from the Purulia district (24.93%) followed by Birbhum (9.44%), Bankura (5%), Howrah (5%), and Hooghly (5%) (Suppl. material 2: table S1).

When asked about their attitude towards monitor lizards in their respective area (Question 12), the negative answers were higher in single districts (e.g., 15.96% vs. 5% in Bankura) than in the previous question, but the average was slightly lower with a value of 9.1% ± 4.5%. In turn, positive attitudes were higher (ranging from 21.67%–43.13%, on average 31.6%) as was the case in neutral answers (x = 46.45% ± 4.3%) (Table 2).

The knowledge of conflict situations (Question 13) was highest among the participants in the Howrah district (47.5%) followed by Hooghly (41%), Birbhum (28.89%), Purulia (28.33%) and Bankura (14.77%) (Fig. 3). One-third (32.10%) of all participants were aware of conflicts within the five districts, while about the same proportion denied this question (x = 33.14%) (Table 2).

Among the three potential areas of conflict provided in the questionnaires (Question 14), fish ponds received the highest scores (on average 14.97%, ranging between 26.88% in Howrah and 6.67% in Birbhum), followed by the open option "others" (on average 12.03%), to which the most common answers were the conflict situation when monitor lizards entered backyards or houses of the villagers in Howrah district. Notably, there were no answers provided from the other districts. The options "poultry" and "garbage" received on average 6.41% and 11.62%, respectively, while 54.95% did not answer this question.

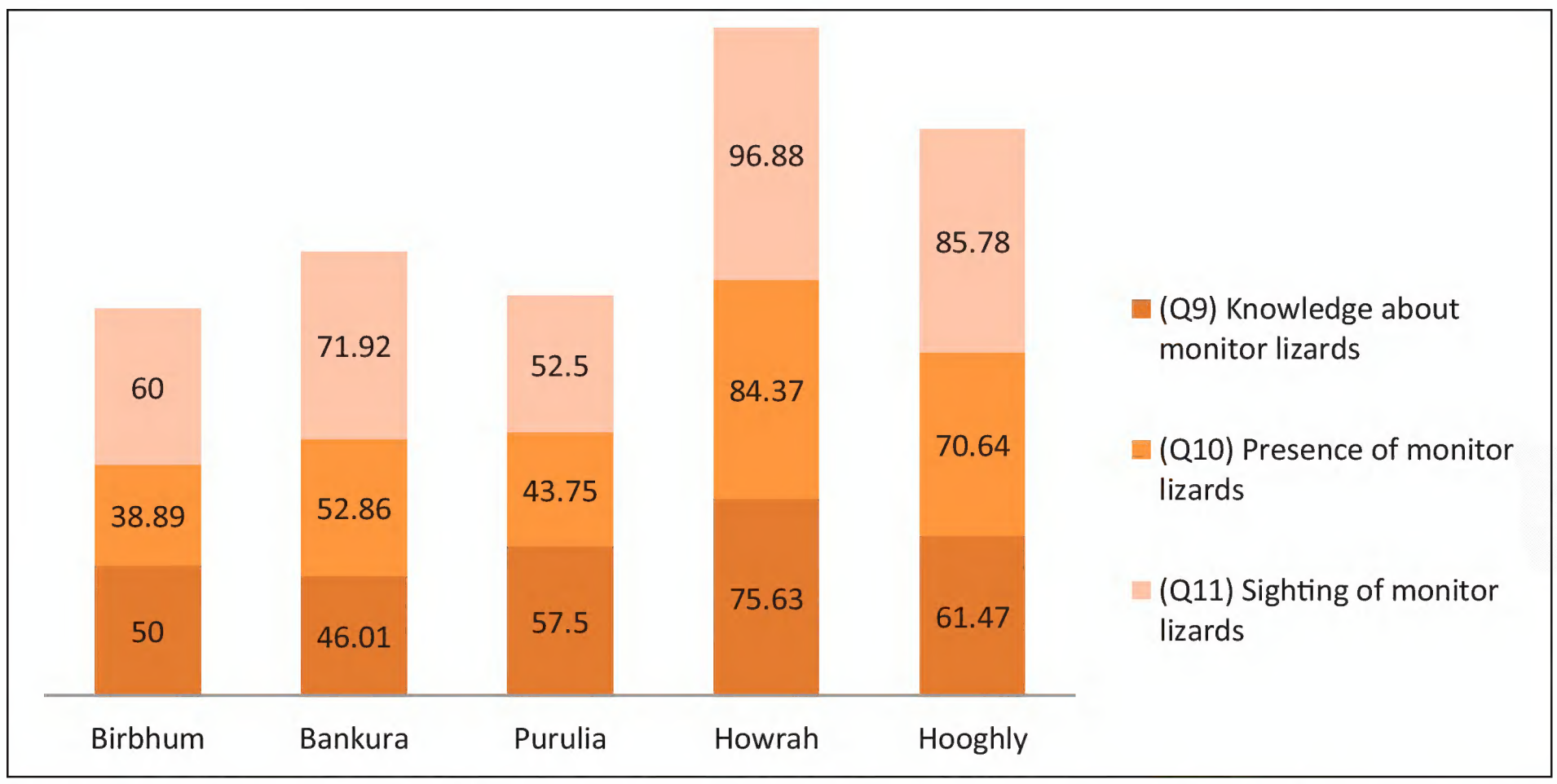

Figure 2. Comparison of the participants' perceptions of the three questions. The questions include the knowledge (Q9), presence (Q10), and sightings (Q11) of monitor lizards found in the five districts expressed in percentages of those who answered "yes". Note therefore, that the sum is not 100% in each column.

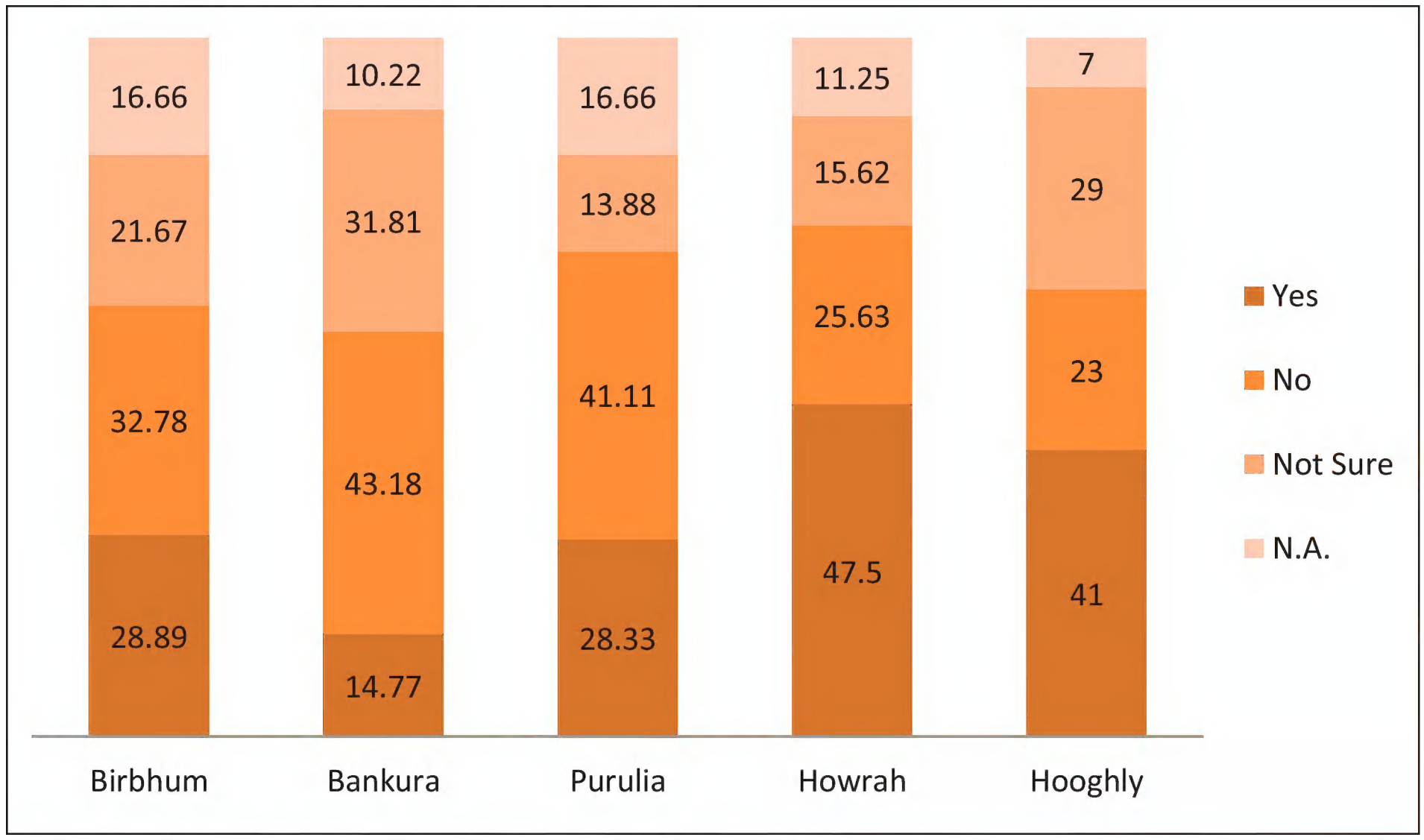

Figure 3. The graph shows the knowledge of conflict situations with monitor lizards among the respondents. This is the result from the five districts expressed in percentages (Question 13).

The knowledge about utilization of monitor lizards (Question 15) was found to be highest among the respondents from Purulia (14.51%) followed by Hooghly (10.55%), Howrah (9.38%), Bankura (8.55%), and Birbhum (5.56%) with an average of 9.71%, while the majority (on average 72.7%) from all districts denied this question (Table 2). The open follow-up question (Question 15a, Table 3) was to specify the purpose of utilization of monitor lizards for those participants who had opted for "yes". Here, the common answers were that the species or their body parts were used for meat (especially the flesh near the belly fat is considered delicious), oil, leather, musical instruments (drums), and medicines. Noteworthily, a high number of participants specifically mentioned that local tribes, such as the Santhals, traditionally consume monitor lizard meat.

Also, the proportion regarding the sightings of the sale of monitor lizards and their parts (Question 16) was highest in Purulia (14.44%), while 2.22% in Birbhum stated "yes". The majority of participants, on average 71.01% ± 5.5% (ranging from 62.01% - 76.61%), denied this question (for more details see Suppl. material 2: table S1).

Among the five districts that provided information on the illegal utilization purposes of monitor lizard parts (Question 16a), the usage as leather was highest (on average 6.32%) followed by oil (2.65%), meat (2.57%), medicines (2.10%), and astrology or witchcraft (1.21%). The perceptions of the use of monitor lizard skin for leather products were found to be highest in Purulia (10.97%) and lowest in Birbhum (1.11%). In comparison, the usage of monitor lizard oil was revealed to be highest in the Bankura district (8.05%) and lowest in Birbhum (0%). The perceptions of the utilization of monitor lizard meat were at almost the same level in all the districts investigated (on average 2.5%). Perceptions of the usage of the species for medicinal purposes were found to range from

Hooghly (3.21%) to Bankura (2.76%), Purulia (2.56%), Birbhum (2%), and Howrah (0%). The utilization in astrology or for witchcraft and mojo purposes such as the use of Hatha Jodi in black magic resulted in 2.63% (Purulia) and 0% (Birbhum) (for details see Table 2, Suppl. material 2: table S1). There was also the open answer option "others" in the question, which was chosen on average by 3.77% of the youth (the highest value was detected in Hooghly with 7.8%) and thus received the second highest percentage of all provided answer options. Here, the most common answers of the participants (who chose "others") were the utilization of the monitor lizards' fat and claws (see questionnaire).

The district with participants who have seen or have participated in the hunting of monitor lizards (Question 17) was highest in Howrah (36.88%) followed by Hooghly (27.06%), Purulia (25.27%), Bankura (23.95%), and Birbhum (23.89%). The majority, however, on average 58.99%, denied this question. For more details about the five districts, please refer to Suppl. material 2: table S1. The open follow-up question (Question 17a, see Table 3) asked those participants who opted "yes" to specify the place or location where they have heard of people hunting the species. The common answers were "in their villages or the neighbouring villages", "near ponds and marshlands of the villages", and "in the nearby forests, open grounds".

The knowledge of Hatha Jodi (also known as Kakanashika or Bagnakhi), a plant root used for Ayurveda medicinal purposes with the newly emerged illegal practice of monitor lizard genitalia being sold as alleged plant roots (Bhattacharya and Koch 2018b; Sharma et al. 2019), was found to be almost negligible among the respondents in the five districts (Question 18). On average, just 3.0% of the students knew about Hatha Jodi, the highest value was from the Purulia district (5.76%), followed by the districts of Bankura (3.83%), Birbhum (2.22%), Howrah (2.5%), and Hooghly (0.92%). The open follow-up question (Q18a) about the personal opinion of Hatha Jodi was answered by only five students, of which four participants from Purulia considered it as a plant root and one respondent from Bankura regarded Hatha Jodi as an animal.

Consequently, very few participants from the districts were aware of persons selling Hatha Jodi (Question 19). On average, just 2.12% of all respondents answered "yes", while the vast majority, on average 78.8%, opted for "no." To the subsequent follow-up question concerning the selling places of Hatha Jodi (Q19a), there was just a single response from a pupil from the Purulia district, who wrote "near my house – used for medicinal purposes."

Whereas, for the question regarding the usage of Hatha Jodi (Question 20), an average of 2.13% decided on the option "yes". On the contrary, 75.37% opted for "no", 14.36% were not sure and 8.11% chose not to answer. There were no prominent differences in the percentages found between the various districts. The next follow-up open question regarding the purpose of the use of Hatha Jodi (Question 20a) had two common answers: "for the treatment of inflammation" and "for black magic or witchcraft." Among those few who were aware of the Hatha Jodi practice, of the three provided categories of potential selling places (Q20b), local marketplaces and astrologers were almost equally chosen by the respondents with, on average, 2.48% and 2.46%, respectively, followed by the online sale (on average 1.43%). The majority of the respondents from all the districts (on average 88.42%) chose not to answer this question. Similar to some earlier questions, online sources were found to be the highest in Purulia district

(4.79%), followed by Hooghly (1.38%) and Bankura (0.98%), but this answer was not opted for by the participants from Birbhum and Howrah. In turn, participants from the Hooghly district favoured astrologers, fortune tellers, and shamans (4.59%) as selling places of the Hatha Jodi. The common responses of the participants for the option "others", which was chosen, on average, by 5.19% were from individual sellers, tribes' men, and locals, who can acquire Hatha Jodi on personal orders. Here, the highest value of 9.99% resulted from the participants of Bankura district (for more details please refer to Suppl. material 2: table S1).

Feedback questionnaire data analysis

The feedback questionnaires were distributed among the participants after the workshops in order to receive some information about the effectiveness of our awareness-raising campaign. The answers per district to the three non-open questions are provided in Table 4. In general, the participants' attitude towards monitor lizards was, on average, 92.96% better than before the workshops (FQ1, see Fig. 4). This overwhelming positive change in attitude was most pronounced in Howrah (98.06%), followed by Birbhum (96.36%), Bankura (94.13%), Purulia (89.86%), and Hooghly (86.38%). Only a very small proportion (on average 0.46%) had an attitude worse than before. Of all participants, 52 students (4.81%) recognized no change in their attitude towards monitor lizards and 1.76% did not answer this question.

Table 4. Summary Results of the open questions from the feedback questionnaire.

Questions	Qualitative answers
QF2	Yes:
	- Learnt from the workshop presentation about the extent and impacts of wildlife utilisation and trade across the world
	- Monitor lizards are nationally protected in India under the Wildlife (Protection) Act of India, 1972 and it is a punishable offence to hunt them
	- Monitor lizards are important for the ecosystem
	- Monitor lizards are used in illegal wildlife trade (hatha jodi) and their numbers are declining globally
	- Monitor lizards feed on venomous snakes
	- It is our responsibility to promote the conservation of wildlife - Hunting festivals are illegal and is a threat to wild species
QF3	- Monitor lizards are nationally protected in India under the Wildlife (Protection) Act of India, 1972
	- Hatha Jodi are actually the hemipenes of monitor lizards and not a plant root
	- Hunting monitor lizards is a punishable offence
	- Monitor lizards feed on snakes
	- Monitor lizards are not a snake species
	- There are four different species of monitor lizards in India
	- Monitor lizards can survive in deserts, but we see them mostly near water bodies
	- There is no scientifically proven evidence about the healing success of the medicinal use of monitor lizard oil
	- Monitor lizards can be of various sizes
	- Local utilisation of monitor lizards is an unsustainable practice and can significantly impact their population
QF6	- We did not get any answers mentioning that anybody would like to use monitor lizard body parts again. For the Option "Would not use again" was answered as follows:
	- It is a punishable offence and violation of the Wildlife (Protection) Act of India, 1972
	- There is no scientifically proven evidence about the healing success of the medicinal use of monitor lizard oil
	- The monitor lizards' population is decreasing due to local utilization
	- The utilization can contribute to illegal trade, for e.g., Hatha Jodi

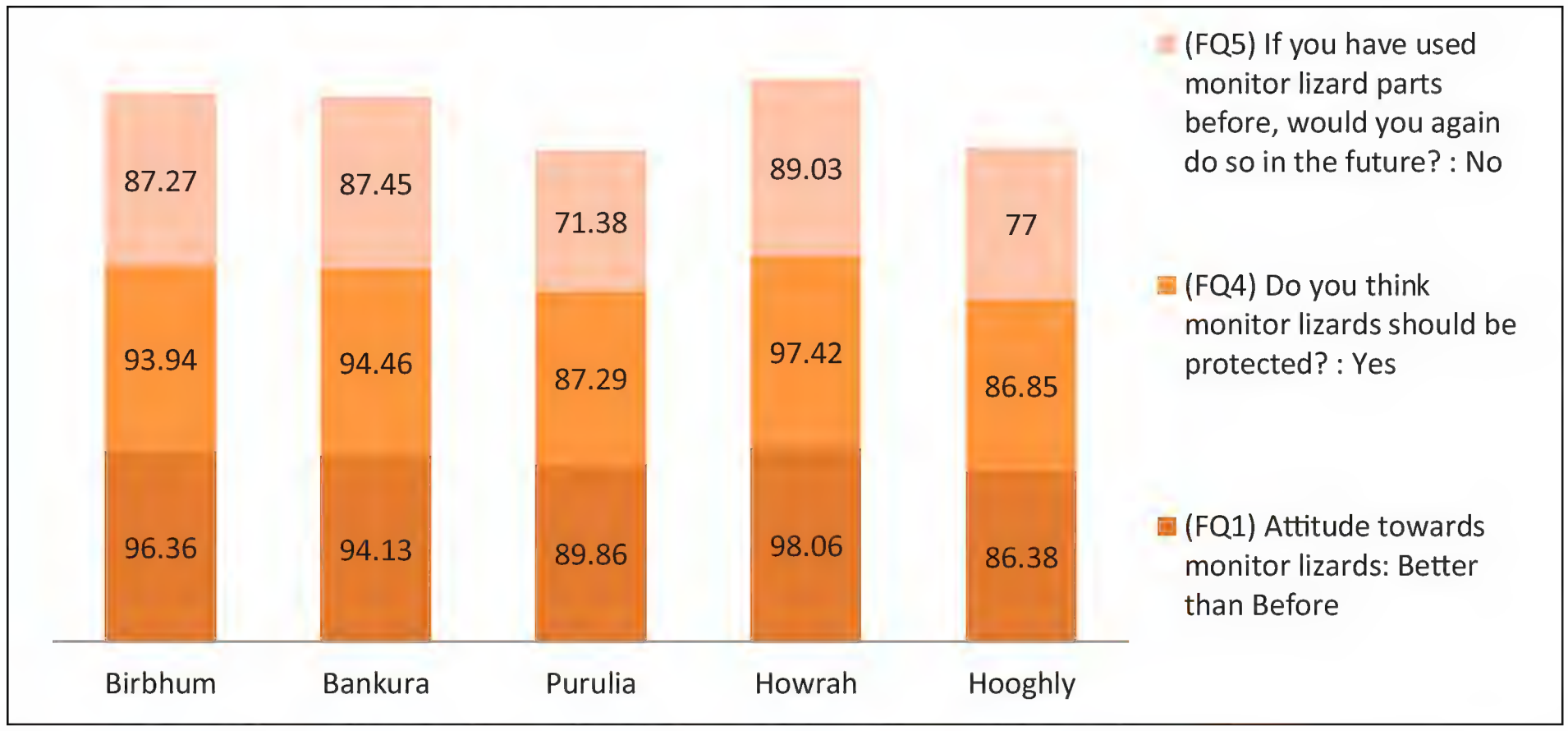

Figure 4. The feedback responses of the participants from the five districts to the three non-open questions. Note that the values are expressed in percentages.

The common opinion concerning the change of attitude of the participants after the workshops (FQ2) was that monitor lizards were previously considered mere pests and were chased away, or in some instances even killed without the presence of any conflicts or reasons. However, after knowing about the habitat fragmentation, threats, and ecological importance of these large reptiles, and how it is ultimately the responsibility of the local inhabitants, especially the youth, to bring about a positive change in the societal norms and rituals, their attitudes and opinions have changed towards the species (see also FQ4).

Most participants mentioned that they had no previous knowledge that the Indian monitor lizards are protected under the Wildlife (Protection) Act of India, 1972, and that utilizing the species or any of their parts is a punishable offense (FQ3). Also, some of the students were surprised to know that monitor lizards can also occur in deserts (i.e., *V. griseus*), as they were only used to observing these reptiles in or near the village water bodies.

Accordingly, after the workshops the majority of participants opted for the protection of monitor lizards (FQ4). Values ranged from 86.85% (Hooghly) to 97.42% (Howrah), (mean: 91.99%). Thirty-one students (2.90%) denied this question, while 2.35% (Bankura) to 6.10% (Hooghly) were indecisive (see Fig. 4 for details). Participants who had used monitor lizards and their body parts before and who did not favor the future use (FQ5, see Fig. 4) ranged between 71.38% (Purulia) and 89.03% (Howrah), (mean: 82.43%), while 5.97% (Purulia) to 0% (Howrah) (mean: 3.04%) were willing to continue the use of monitor lizards after the workshops. Between 6.06% (Birbhum) and 16.52% (Purulia) (Suppl. material 2: table S2), (mean: 10.29%), stated being not sure.

The most common answer to the question (FQ6), why they would or would not utilize monitor lizards or their body parts in the future, was that, after the workshop presentations and discussion session, they had learned that if the species are further exploited for their body parts, then they might get locally extinct. Also, another opinion was that there is no scientific evidence on the medicinal efficacy of monitor lizard oil, which is locally used for the

cure of rheumatism and muscle sprains. There were no written responses regarding the students' willingness for the future utilization of monitor lizards or their parts.

Discussion and conclusions

Data obtained from the questionnaires provided a clear understanding of the attitudes and perception trends of the young participants from the five districts studied in West Bengal. The "rural" and "urban" areas refer to the specific localities of the participants from each district. The baseline data regarding the various categorized questions treated above can be used to recognize the presence, sightings, interactions, local utilizations, hunting pressures, conflicts, and the illegal trade of monitor lizard species in human-dominated landscapes of eastern India.

Based on our study findings, the perception of the presence of wetlands (Q5+6) can be correlated with that of the presence of monitor lizards (Q10). The presence of wetlands was found to be the highest among respondents of Howrah and the least from Purulia. In this regard, it is interesting to note that Howrah exhibited the highest percentage (55.62%) of urban respondents, and considering the comprehensive perception data, such as the presence of monitor lizards (84.37%), it may be interpreted as an indication for the ecological adaptability of monitor lizards to human-influenced environments (Uyeda 2009; Bhattacharya and Koch 2018a). Similarly, perceptions of the knowledge (Q9), presence (Q10), and sightings (Q11) were found to be the highest in Howrah and the least in Purulia (Fig. 3), which suggests that most respondents from Howrah were aware of the presence of monitor lizards in their region. This interpretation can be reconciled with the highest percentage regarding conflict situations (Q13+14) with monitor lizards attracted by fish ponds.

The perceptions of the use of monitor lizard skin as leather products and the knowledge of Hatha Jodi were found to be the highest in Purulia. These trends may indicate that although the perception of the presence of monitor lizard species was the least in Purulia, their local illicit use and trade might be the highest. Similarly, sightings of products made from monitor lizard parts were significantly higher (14.44%) in Purulia compared to the other districts, which might suggest the more frequent presence of local markets selling illegal wildlife products in the district. In this context, it is noteworthy to mention that one of the participants from Purulia stated in the open questionnaire that monitor lizard products, such as oil, belly fat, and claws were openly sold in some of the local marketplaces.

Interestingly, perceptions of the hunting of monitor lizard species were similarly categorized in all five districts (See Suppl. material 2: table S1, Q17). This trend may indicate the equally high extent of illegal hunting and local utilization of monitor lizards irrespective of the perception of their presence in the five districts. However, the highest proportion was observed in Howrah (36.88%), potentially due to the high perception values related to the presence (84.37%), sightings (96.88%), as well as conflicts with the monitor lizards subjected to fish ponds (26.88%) compared to the other districts. Despite the above facts, the perception data values regarding the utilization of the monitor lizards (see Q15, Q16, Q16a from Suppl. material 2: table S1) and with reference to Hatha

Jodi (see Q18, Q19, Q20, Q20b; Suppl. material 2: table S1) were comparatively found to be lower than the majority of the districts. This observation would imply that although monitor lizards are being hunted, infrastructure (e.g., local markets) in Howrah is absent or negligible to encourage trade in illegal wildlife, as compared to Purulia.

Besides, during the workshop presentation session, we asked the participants about the Wildlife (Protection) Act, 1972, concerning the protection of monitor lizard species in India. The majority of school and college students were unaware of the existence of such national laws. Therefore, a simple measure to disseminate information about nature conservation laws and to improve local knowledge about protected wildlife species could be the installation of information boards near suitable and possibly protected habitats. Also, to simultaneously emphasise the importance of protecting ecosystems and biodiversity to generate ecosystem services considered essential to human health as well as to sustain livelihoods for local communities (Keane et al. 2011; Redford et al. 2022).

Knowledge regarding the Hatha Jodi trade was negligible among the students queried in the five districts. Only a few participants from Purulia, Bankura, and Birbhum appeared to have been confronted with these items and their trade. However, since it is not known whether the information about these illegal activities has already been passed on in the five districts, this could be an explanation for the clear reticence of the respondents. Besides, another interpretation is that the young respondents from the schools and colleges were not yet the direct consumers of Hatha Jodi. The answers suggested that the selling places of Hatha Jodi in these districts were mostly in markets, from astrologers, and through online shopping sites. A crucial observation is that the illegal sale of such items is often easier through commercial online sites (Lavorgna 2014; Harrington et al. 2021). In contrast, in the outskirts the sale of Hatha Jodi is considered suitable in open marketplaces or through astrologers, likely a result of lacking or inappropriate legislation, enforcement, and the failure to provide information and awareness on national legislation in these remote regions.

The feedback data analysis indicates the success and effectiveness of our workshops. A considerable proportion of participants (mean: 92.95%) recognized a positive change in their attitude towards monitor lizards after the workshop sessions. Similarly, the majority of the participants (mean: 91.99%) from all five districts supported the protection status of all Indian *Varanus* species. Likewise, an average of 82.42% of all participants were against the future use of the monitor lizards or their parts, which gives reason for confidence in future compliance with the existing laws for the protection of these giant reptiles in West Bengal. However, there might be biases due to the social desirability/undesirability of the answers provided (Gordon 1987).

Nevertheless, awareness workshop programs are an integral part of species conservation measures as a result of, and in conjunction with, scientific research (Ardoin et al. 2020). As stated by Castillo-Huitrón et al. (2020), perceptions, beliefs, and experiences help to shape the structure of a society. Besides, in human-dominated landscapes, to address the issue of species conservation in general, it is equally essential to consider the attitudes of local communities as that of the ecological parameters of the species occurring in the region

(Mascia et al. 2003). The results of a similar study on the awareness program of the Komodo dragon (*V. komodoensis*) in Indonesia were found to have positive attitudes among elementary school students concerning the diet, habitat, and conservation efforts of the species (Kamil et al. 2020). These results can be compared to our study, wherein in the feedback question (FQ1) the majority of the respondents (92.95%) agreed that their attitude towards monitor lizards has considerably improved after the awareness workshops had taken place (for details see Suppl. material 2: table S2).

Similarly, a study about the perceptions and conservation awareness of local citizens towards the endangered marine green turtle (*Chelonia mydas*) in Malaysia was found to be more positive among the younger generation when compared to the older ones. Often, it is more difficult for the older generation to break away from their traditional beliefs and adapt to alternative behaviors (Mutalib et al. 2013). Furthermore, the study also revealed that the younger respondents were more sensitive toward educational programs which have prominently increased their awareness towards the conservation of sea turtles in Setiu, Malaysia (Mutalib et al. 2013); a joint finding with this study. A study on the conservation of the cotton-top tamarins in Columbia, found valid evidence of the engagement of youth following in the conservation of the critically endangered primates in the region, and that the knowledge of the students significantly increased ($p < 0.01$) after conservation education programs were performed (Feilen et al. 2018). Another study by Salazar et al. (2024) found a significant positive increase in the local knowledge of rural school children aged 10–13 years in India as a result of conducting educational programs in the areas affected by human-wildlife conflicts.

Thus, from the few results of the above-mentioned studies, it is obvious that the youth can be motivated and inspired to develop a positive attitude toward the conservation of a certain species (Mutalib et al. 2013; Feilen et al. 2018; Kamil et al. 2020; Salazar et al. 2024).

Findings of Sánchez-Mercado et al. (2020), concerning the illegal trade of the yellow shouldered Amazon (*Amazona barbadensis*) in Venezuela, were found to be linked to the perceptions and attitudes of the local communities. Subsequently, the evaluation of the perception trends of the communities were used to design effective conservation programs in the study (Sánchez-Mercado et al. 2020). In addition, the baseline perception data obtained from our workshops can be used to analyze ecological factors, threats, utilizations, and conflicts related to the monitor lizards among the respondents of the five districts.

In conclusion, once the negative perception trends are analysed in a particular area, they could be further addressed and gradually altered with more such workshop programs over a specific period. Over-exploitation of natural resources commonly results from the lack of enforcement and regulations being ignored (in this study the interviewees learned about the protected status of the monitor lizards for the first time). However, the involvement of local people as stakeholders, e.g. leading such educational campaigns, could reduce exemplified violations (Secretariat of the Convention on Biological Diversity 2004).

Therefore, awareness workshops (which are to be continuously adapted and improved according to gained experience) should be regularly conducted in areas where protected wildlife species such as monitor lizards (threatened and yet to be nationally protected) are illegally exploited for domestic use and trade.

This approach will further help to promote and encourage local communities and the young generation to develop a positive attitude and responsibility towards conservation of vulnerable wildlife and their ecosystems in human-dominated landscapes. Based on these findings, it can be deduced how changes in ecosystems affect human well-being and poverty reduction and why the sustainable protection of ecosystems and their biotic communities contributes to human well-being (Millennium Ecosystem Assessment 2005). The benefits that nature provides are determined by the maintenance of resilient ecosystems, their services, and values (TEEB 2010). Nature Contributions to People (NCP) are intertwined with the non-anthropocentric value of nature and the anthropocentric value that is conducive to a good quality of life (Pascual et al. 2017). These essentials need to be disseminated in local communities as part of subsequent educational campaigns.

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The authors have declared that no competing interests exist.

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Data availability

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

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Supplementary material 1

Questionnaires of the awareness workshops

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Supplementary material 2

Supplementary tables

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Data type: pdf

Explanation note: **table S1.** Workshop questionnaire (Pre-Presentation) results of the multiple-choice questions from respondents of the five districts. **table S2.** Results of the feedback questionnaire for the three non-open questions.

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